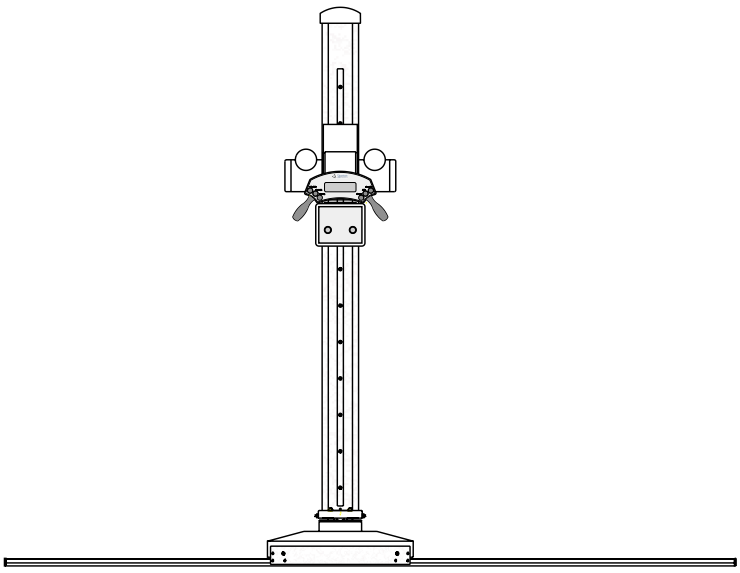
Quantum
MEDICAL IMAGING, LLC

Model QS-550

Free-Standing Tubestand

Service Manual



Manual Part No. DC30-009 Revision B

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Revision History

REVISION	DATE	TYPE OF MODIFICATION
A	12/7/00	Initial Release.
B	2/28/01	Minor modification made to installation of tube stand on floor track procedure.

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1 - 47	B				

Revision History

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Chapter 1

SPECIFICATIONS

PHYSICAL SPECIFICATIONS

SYSTEM SPECIFICATIONS

- Column Height: 92.0 inches (2336.8 mm)
- Tube Mount: Fork or Trunnion
- Weight: 600 lbs. (272.0 kg)
- Collimator Compatibility: Manual, Selectable or Automatic, 10 - 20 lbs. (typical). Mounting to fork/tube housing requires four 1/4-20 or M6 x 16 bolts spaced on a 3.625" diameter circle
- X-ray Tube Compatibility: 3" or 4" rotating anode type, 30 - 40 lbs. (typical)

HANDGRIP SPECIFICATIONS

- Controls: Switches (Vertical, Longitudinal, Angulation,Transverse, All Locks), Auto-Stop
- LED Indicators: 40” (100 cm) SID, 72” (180 cm) SID
- LCD Display: 40 inches (100 cm) and 72 inches (180 cm) SID, tube rotation angle, time, date, x-ray generator technique selection when APR mode is activated (or mode [i.e., AEC/Manual] when not in APR mode)

PERFORMANCE SPECIFICATIONS

- Tubestand Longitudinal Travel: 96.0 inches (1752.6 mm)
- Vertical Travel (x-ray tube): 60.0 inches (1524.0 mm)
- X-ray Tube Height:
  Maximum: 72.5 inches (1848.2 mm)
  Minimum: 13.0 inches (330.2 mm)
- Transverse Tube Travel: ±5 inches (127 mm) from centerline of table
- Transverse Travel Detent: Center position
- X-ray Tube Angulation: 240° (±120°)
- X-ray Tube Angulation Detents: 0°, 90°(CW), 90°(CCW)
- Column Rotation: 180° (±90°)
- Column Rotation Detents: 0°, 90°(L), 90°(R)

Chapter 1 Specifications

ELECTRICAL SPECIFICATIONS

Note: The following specifications are for the tubestand only and do not apply to the x-ray tube or collimator. Refer to x-ray tube and collimator manufacturer's documentation (supplied with the tubestand) for applicable specifications.

- Locking System Power: +24 VDC, 1.0 Ampere
- Mode of Operation: Continuous
- Power Supply Type: Double (or Reinforced) Insulated (must meet construction/performance criteria per UL 2601-1)
- Electrical Interfacing: Tubestand-mounted terminal strip for interfacing +24 VDC and, when equipped with automatic collimator, tray sensing signals

SYSTEM OPTIONS

- Six-Button non-LCD type Handgrip
- Fork Mount (replaces Trunnion Mount)
- Floor Grout Kit

SYSTEM OPERATING ENVIRONMENT

Note: The tubestand is not designed for use in the presence of explosive or flammable gases as might be found in operating rooms.

- Ambient Temperature: +10°C to +40°C
- Relative Humidity: 20 to 80%, non-condensing
- Altitude: -30.5 to +2440 meters relative to sea level

NON-OPERATING ENVIRONMENT

Note: Operation or prolonged storage temperatures below 32 degrees Fahrenheit should be avoided as it will cause lubricants to become more resistive to manually-operated motions.

- Ambient Temperature: -18°C to +70°C
- Relative Humidity: 20 to 95%, non-condensing
- Altitude: -30.5 to +3048 meters relative to sea level

COMPATIBILITY STATEMENT

The Quantum Medical Imaging, LLC. tubestand is compatible with all Quantum Medical Imaging, LLC. manufactured tables, wall stands, and high-voltage x-ray generators, and with other manufacturer's equipment having equivalent means for indication of SID and perpendicularity.

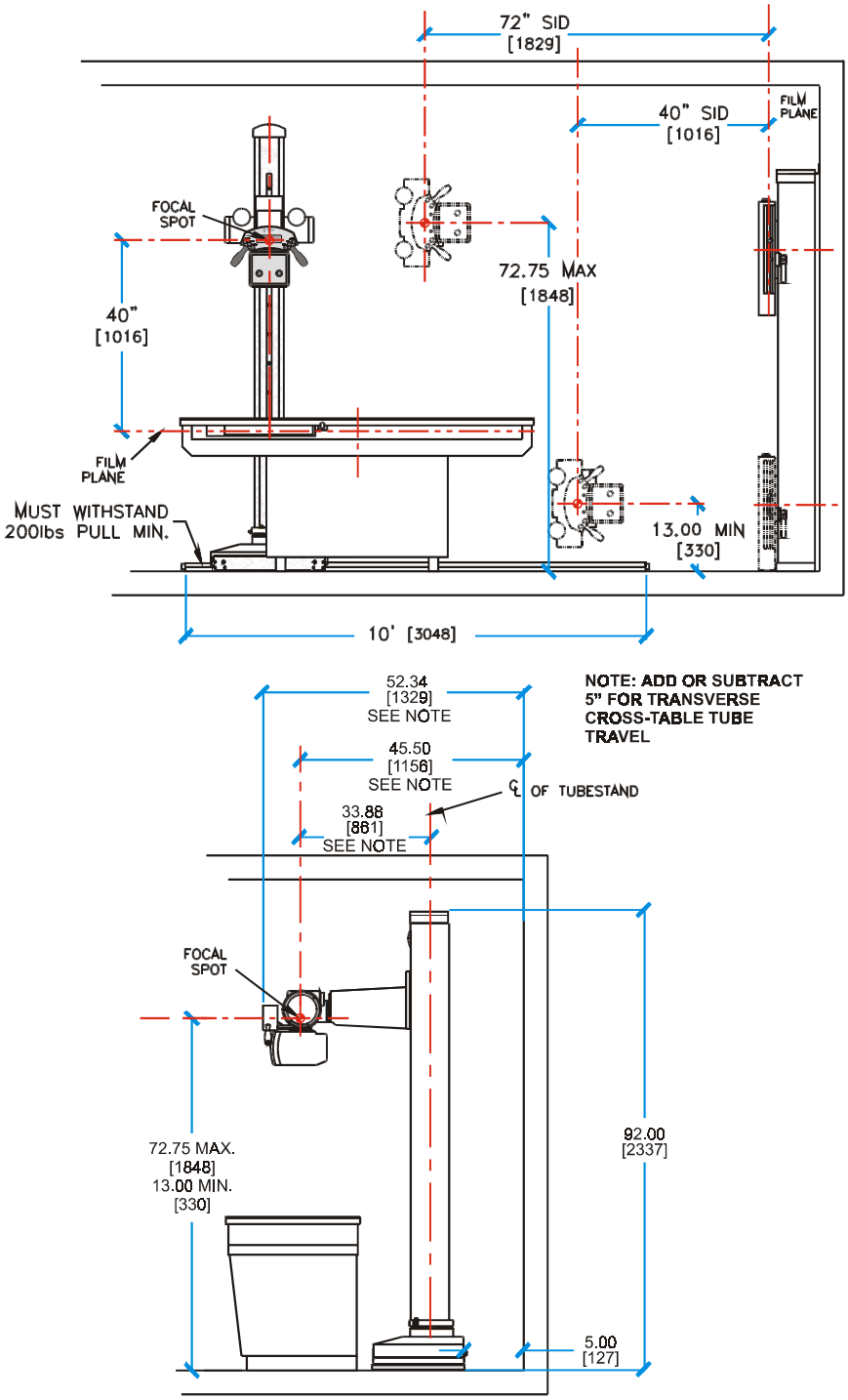

Figure 1. Model QS-550 Tubestand Configuration Diagram

Chapter 1 Specifications

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Chapter 2

ASSEMBLY & INSTALLATION

Chapter 2 Assembly & Installation

OVERVIEW

This chapter describes the steps required to assemble and install the Model QS-550 Tubestand, including making all required electrical connections, and performing all required alignments and calibrations.

ROOM CONSTRUCTION

A conventional radiographic room construction should be used in the area where the tubestand is to be installed. Consult with your State Health Department or local Building Codes for specific radiation shielding requirements.

INSTALLATION PRECAUTIONS

Install the tubestand before installing the radiographic table.

Check that the space location, conduit arrangements and junction boxes are prepared for the permanent installation of the tubestand. Verify that the location and space allowed is sufficient for the full range of tubestand/Transverse Arm travel without hitting any walls or structures in the room (see Figure 1 for equipment dimensions). Note that the Transverse Arm in/out adjustment and the Vertical Column position relative to the rear wall are critical. Column rotation in the counterclockwise (right-hand) direction could result in the Tube Housing striking the wall before the 90 degree index position is reached.

CDRH CERTIFICATION

The tubestand is not a CDRH certifiable product. However, it must be compatible and operate in conjunction with other components in the x-ray system so that the x-ray system performs in compliance with CDRH performance standards.

REQUIRED TOOLS AND MATERIALS

The following tools and materials are required to complete the assembly and installation procedures:

- Double-bubble level - two feet minimum length
- Tape Measure - eight feet minimum length
- Standard hand tools
- Alcohol - to clean the high-tension cable ends, tubehead, and high- tension transformer sockets
- Dow-Corning DC4 vapor-proofing compound, silicon insulating grease or equivalent - for packing x-ray tubehead and high-tension cable terminals
- Special film cassette (11" x 14" cassette with scribed centerline)
- Electric drill and drill bits
- Lubricant - white lithium grease

Chapter 2 Assembly & Installation

UNPACKING

Open crate or carton marked "packing list enclosed" first. Remove packing list and use it as a guide to open the remaining cartons. Do not dispose of packing material until packing list is matched with actual parts received. Should there be a shortage or damage, notify Quantum Medical Imaging, LLC.'s customer service department immediately. The manufacturer is relieved of any responsibility for damage during shipment after unit is picked up by the carrier.

NOTE

Examine all cartons and crates carefully at time of delivery. If damage is apparent, have delivery driver write a "Damaged Shipment Note" on copies of freight bill, sign it, and file appropriate carrier claim. Should you discover concealed damage, immediately notify the transporting agent and ask for an "Inspection of Damage". Carrier will not accept concealed damage claim if filed after 15 days from date of receipt of merchandise.

INSTALLATION INSTRUCTIONS

When the Tubestand is used with a vertical wall frame or wall stand, care should be taken during room planning and pre-installation to allow for the accurate alignment of these components. Alignment accuracy must be within 2% of the SID used. After the tubestand Floor Track is aligned with the table receptor, the track cannot be adjusted transversely. Therefore, transverse alignment of the x-ray field to the image receptor in the vertical wall frame or wall stand must be made by adjusting the position of the image receptor within the wall stand or relocation of the entire wall stand.

All mounting procedures must be approved before and checked after installation by the hospital or facility engineering department and a registered, professional, structural engineer. It is recommended that a leakage current measurement be taken following installation to verify system meets allowable levels.

To assemble and install the tubestand, refer to Figures 2 through 20 and proceed as follows:

Floor Track Installation

The area of the floor on which the Floor Track is to be mounted must be level in all directions. Shims may be used, however, grouting is recommended.

1. Position the Floor Track in the proper location for installation.
2. Using a bubble-level, check that the Floor Track is level both longitudinally and transversely. If not, shims can be used to level track, however, grout is recommended.
3. Fasten the Floor Track to the floor using appropriate fastening hardware (capable of supporting 100 lb. pull-load) depending on the installation site (see Figure 2).
4. Install five (5) Hole Plugs in holes for floor mounting screws.

Vertical Column/Base Assembly Attachment

Mount the Base Assembly to the Vertical Column and secure with the supplied retaining ring at the bottom of Vertical Column (see Figure 3).

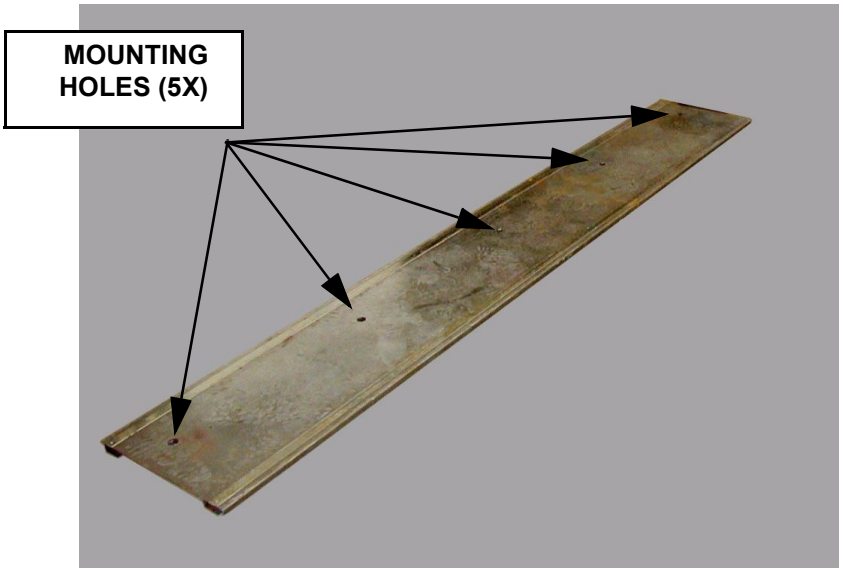


Figure 2. Floor Track Installation

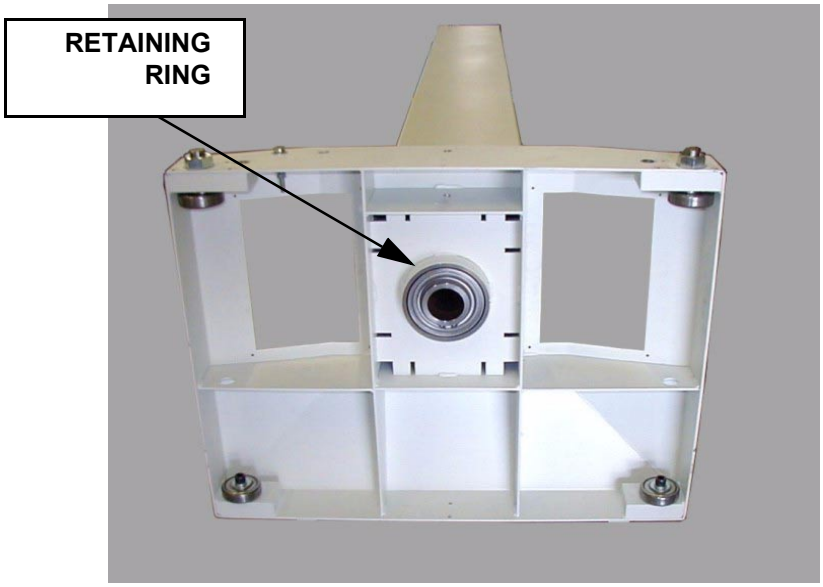


Figure 3. Installing the Column Retaining Ring

INSTALLING TUBESTAND ON FLOOR TRACK

1. Remove the End Cap from one end of the Floor Track.
2. At the end of Floor Track without End Cap, slide the Front and Rear Bearing Bracket Assemblies into the Floor Track.
3. Raise the Base and Vertical Column onto the Floor Track.
4. Securel the Front and Rear Bearing Brackets to the Base Assembly (see Figures 4 and 5).

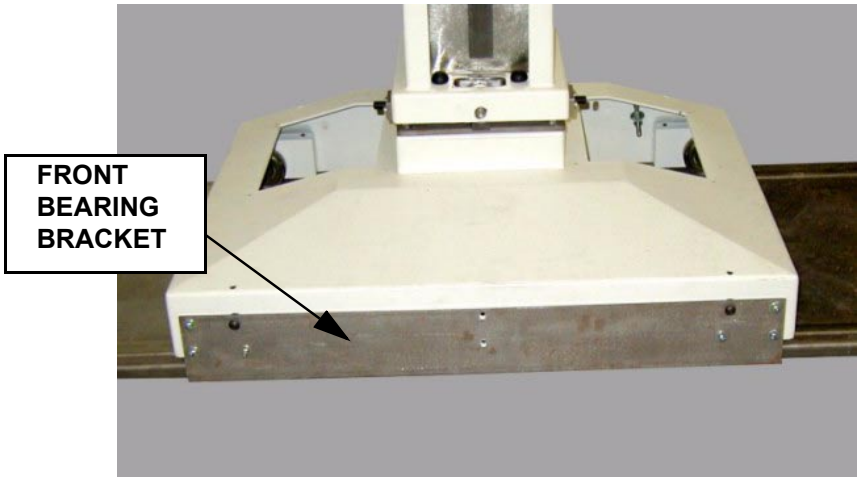


Figure 4. Bearing Bracket Locations

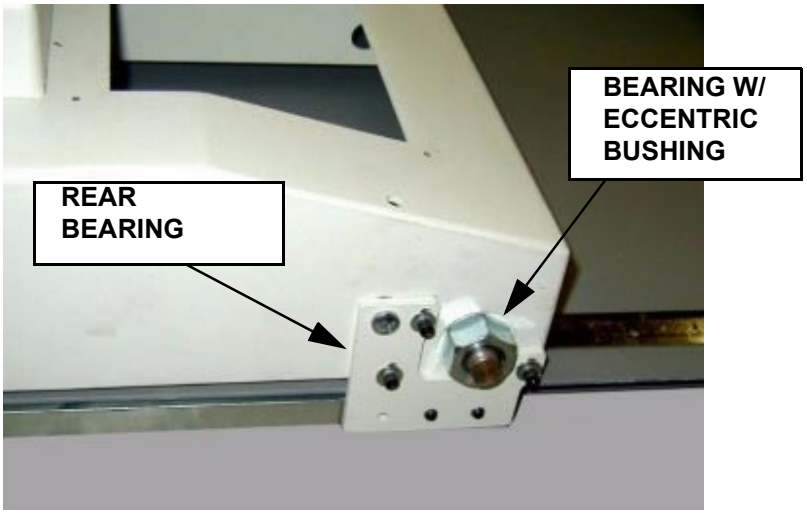


Figure 5. Vertical Column Angle Adjustment

CAUTION! When Bearing Brackets are removed, extreme care must be taken not to tip over the Base Assembly and Vertical Column. The Base Assembly and Vertical Column should not be left standing unattended at any time. Re-install Front and Rear Bearing Brackets immediately once the column is raised.

5. Re-install the End Cap to the end of the Floor Track using four (4) 5/16-18 x 1/2" hex head bolts, lockwashers and flat washers.
6. Using a two-foot (minimum) double-bubble level, placed on the front of the Vertical Column, check that the Vertical Column is plumb. If not, adjustment can be made by rotating the two (2) Vertical Angle Adjustment Bearings with eccentric bushings (see Figure 5). Loosen the two (2) eccentric bearings mounted to the rear of the Base Assembly; rotate the bearings to adjust. Re-tighten the bearings after the column angle adjustment is made.

INSTALLING THE TRANSVERSE ARM

1. Align mounting holes in the Transverse Arm with holes in Vertical Column Trolley and install four (4) 3/8-16 x 1-1/2" hex head bolts and lockwashers (see Figure 6).

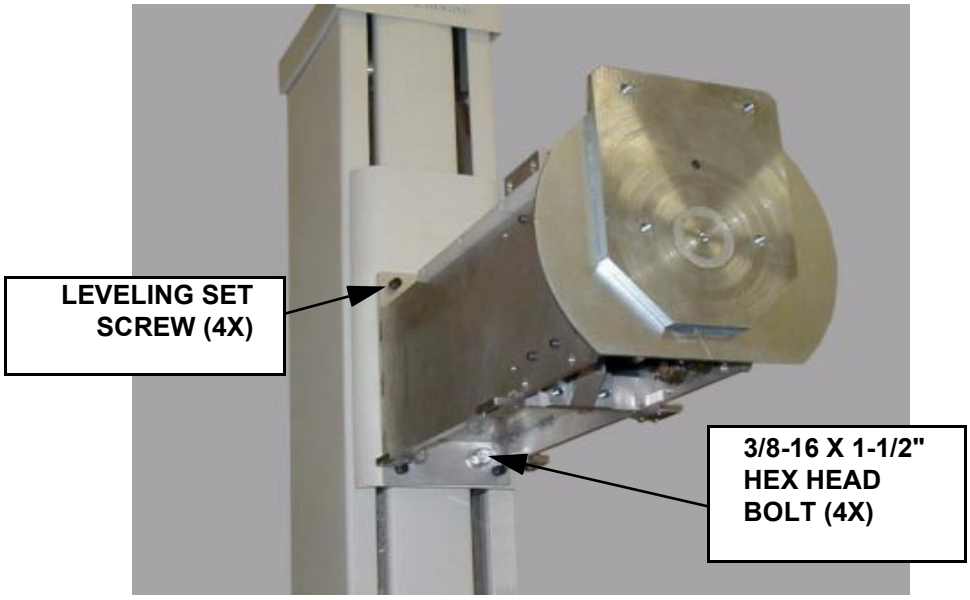


Figure 6. Installing the Transverse Arm

2. Place a level on top or bottom of the Transverse Arm (from front to back). If not level (±1.0°), verify the Floor Track and Vertical Column are level.
3. If both Floor Track and Transverse Arm are level, loosen four (4) 1/4-20 x 1-1/2" hex head bolts securing Transverse Arm to Trolley.
4. Adjust four (4) set screws as required to level Transverse Arm (see Figure 6).
5. Re-tighten four (4) 1/4-20 x 1-1/2" hex head bolts.

INSTALLING THE X-RAY TUBE, COLLIMATOR AND HANDGRIPS

CAUTION! The tube angulation lock is not a mechanical lock; electrical power must be applied to hold angulation. During installation, the x-ray tube and collimator must be held to prevent free-turning. Mount the collimator per instructions supplied by the collimator manufacturer.

The system is supplied with either a Trunnion type x-ray tube mounting bracket or a Tube Mounting Fork. Refer to the appropriate paragraph that follows corresponding with the type of x-ray tube mounting bracket used on your system.

Trunnion Configuration

1. Install the Trunnion Assembly onto the Transverse Arm using four (4) 1/4-20 x 2" hex head bolts and lockwashers (see Figure 7).

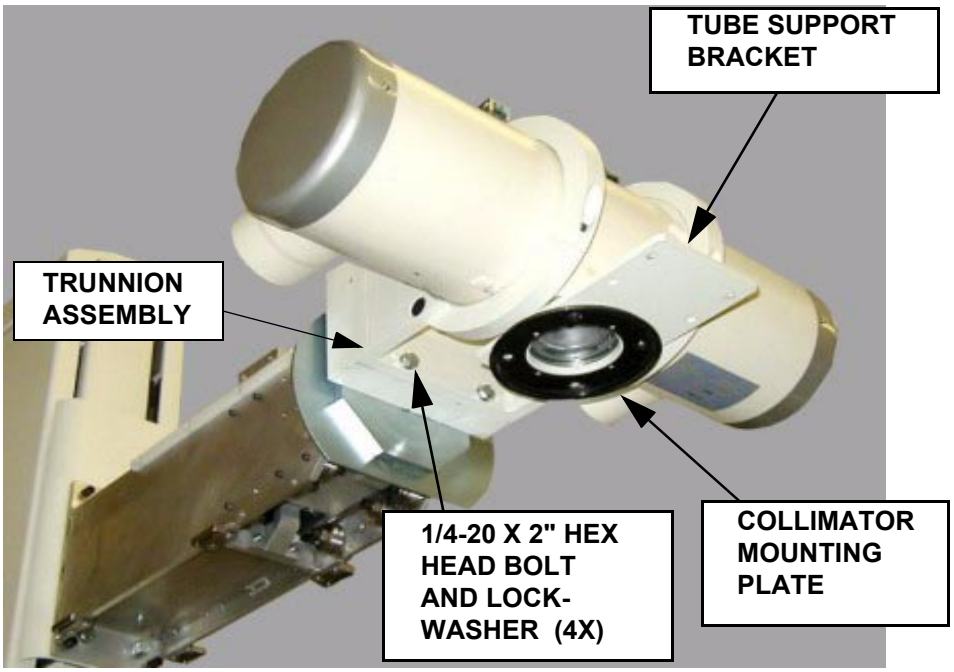


Figure 7. Mounting the Tube and Trunnion Assembly

2. Remove top half of Trunnion Rings.
3. Place x-ray tube onto lower half of Trunnion Rings and re-mount upper half.
4. Install Trunnion Handle on Trunnion Assembly using two (2) 1/4-20 x 1/2" button head socket screws (see Figure 8).

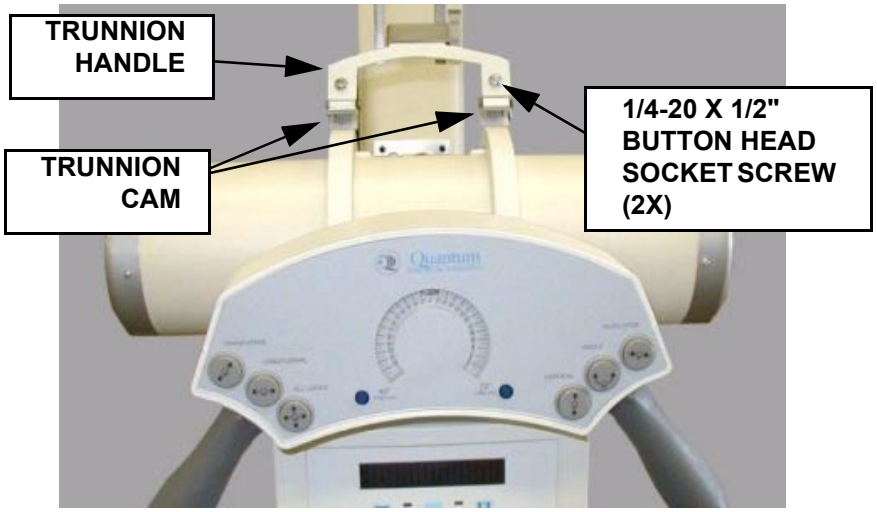


Figure 8. Trunnion Handle Installed

5. Check trunnion handle locking. If too loose, remove Trunnion Handle and rotate each Trunnion Cam clockwise a few turns. If too tight, remove Trunnion Handle and rotate each Trunnion Cam counterclockwise a few turns. Re-install Trunnion Handle and re-check locking. Repeat until properly adjusted.
6. Remove the Collimator Mounting Plate from the collimator.
7. Attach the Collimator Mounting Plate to the Tube Support Bracket and x-ray tube. Use required spacer(s) supplied with collimator between x-ray tube and Tube Support Bracket.
8. Mount Tube Support Bracket onto Trunnion using four (4) 1/4-20 hex head bolts.
9. Mount Handgrip Assembly on Tube Support Bracket (in front of the x-ray tube) using four (4) 1/4-20 x 1" hex head bolts (see Figure 9).

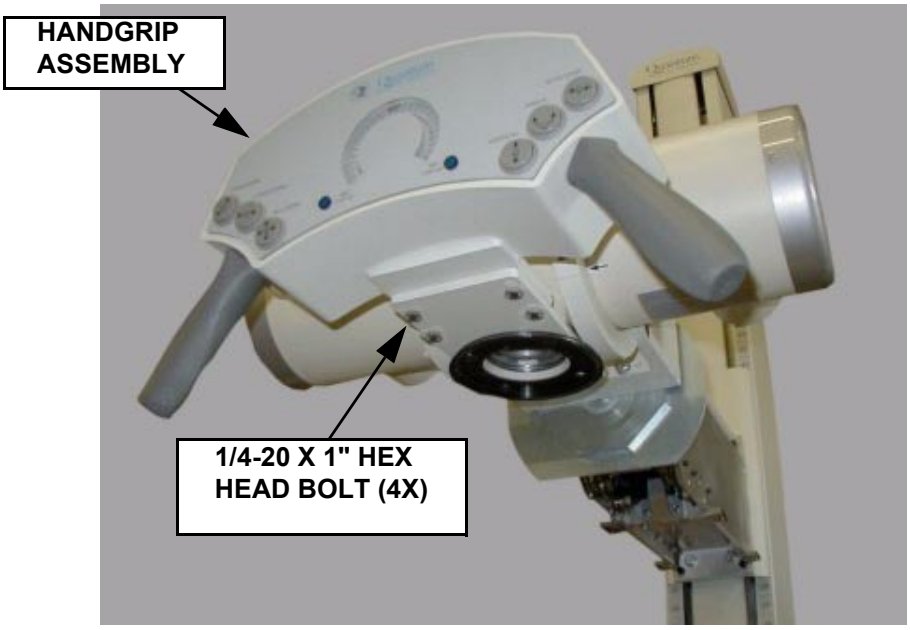


Figure 9. Installing the Handgrips

10. Rotate the Handgrips/tube 120° (i.e., nearly upside down). Install collimator on Collimator Mounting Plate using Collimator Mounting Ring (see Figure 10).
11. Affix supplied rubber bumper to Angulation Plate in location where collimator contacts Angulation Plate when in fully rotated position.
12. Affix Trunnion angulation labels (scales and pointers) as follows:
    a. Affix pointers on x-ray tube.
    b. Place angulation scales on Trunnion Mounting Rings so that a scale can be viewed from either side of the tubestand, and with the pointers (on tube) pointing to 0° on angulation scales.
13. Route Handgrip cable (from terminal block TB1) to D-connector on rear side of the Handgrip Assembly and connect.
14. Connect collimator cables as required (refer to collimator manual and to Figure 27 or 28 in Chapter 5, Diagrams).

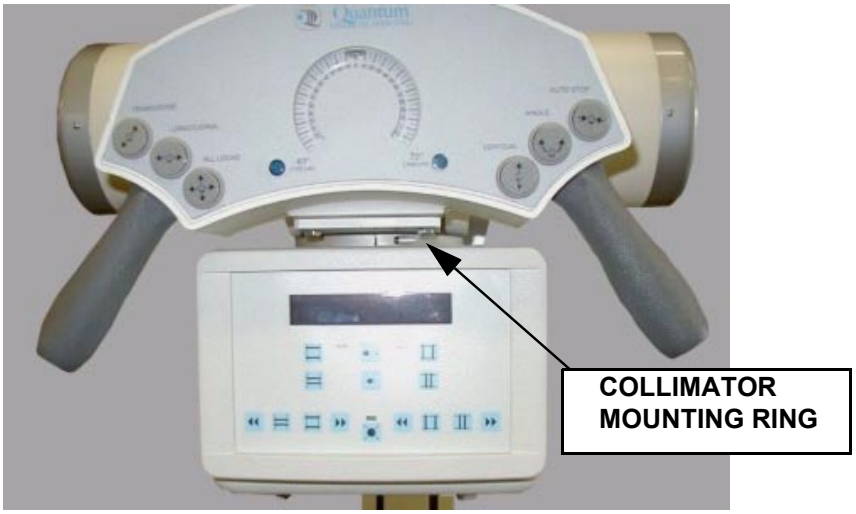


Figure 10. Collimator Installed

Tube Mounting Fork Configuration

1. Position the Tube Support Bracket on the Tube Arm Extension, with the top two slots centered on mounting holes, and secure using four (4) 1/4-20 x 2" hex head bolts and lockwashers (see Figure 11).Remove Collimator Mounting Plate from collimator and install Collimator Mounting Plate (with appropriate spacers, supplied with collimator) and x-ray tube on Tube Fork.
2. Mount the Handgrip Assembly (in front of the x-ray tube) using four (4) 1/4-20 hex head bolts (see Figure 9).
3. Install collimator on Collimator Mounting Plate using Collimator Mounting Ring (see Figure 10).
4. Route Handgrip cable (from terminal block TB1) to D-connector on rear side of the Handgrip Assembly and connect.
5. Connect collimator cables as required (refer to collimator manual and to Figure 27 or 28 in Chapter 5, Diagrams).

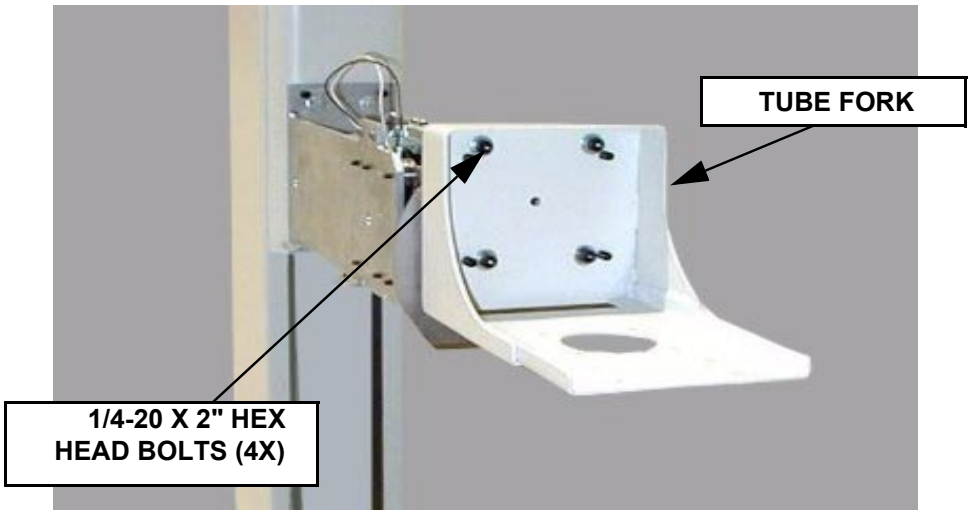


Figure 11. Mounting the Tube Fork

Leveling the Collimator

Place a level on top or bottom of the collimator (from front to back). If not level, proceed as follows:

1. Loosen four (4) 1/4-20 x 2" hex head bolts securing Trunnion (or Tube Mounting Fork) to Transverse Arm.
2. Adjust set screws as required to level collimator (see Figure 12).
3. Re-tighten four (4) 1/4-20 x 2" hex head bolts.

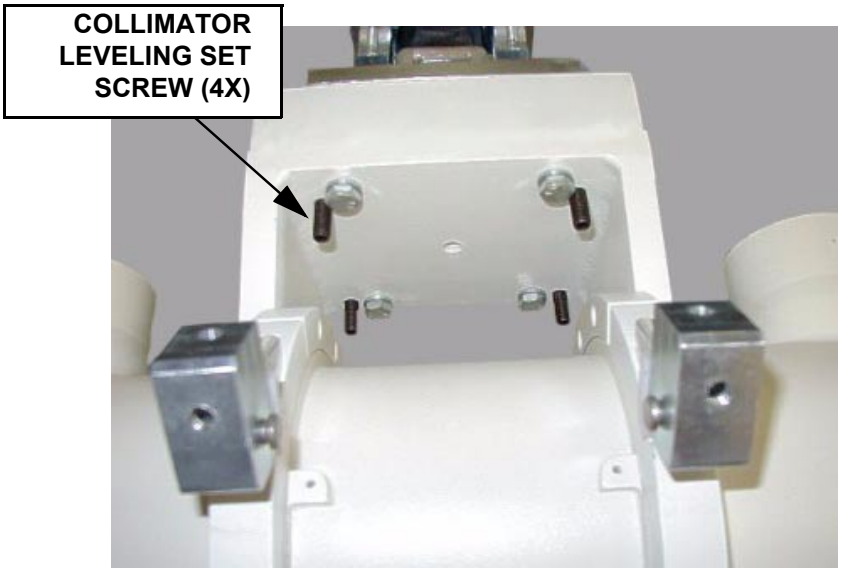


Figure 12. Collimator Leveling Adjustment Set Screws

TRANSVERSE ARM COVERS INSTALLATION

Refer to Figures 13 and 14 and proceed as follows:

1. Position the Transverse Arm Inner Cover as shown in Figure 13 and secure to Transverse Arm using six (6) 8-32 x 1/4" button head socket screws.
2. Carefully position the Transverse Arm Outer Cover over the Transverse Arm Inner Cover. The holes in the four (4) mounting tabs attached to the inside bottom edge of the Transverse Arm Outer Cover should be aligned with the holes in the four (4) mounting blocks on the underside of the Transverse Arm Assembly.
3. Position the Transverse Arm Lower Cover as shown in Figure 14 and secure it to the Transverse Arm using four (4) 6-32 x 3/4" flat head screws.

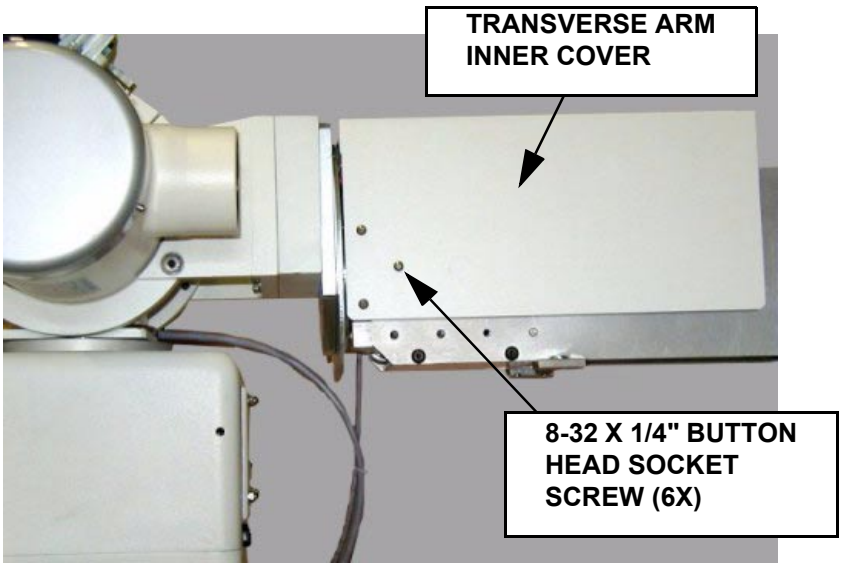


Figure 13. Installing the Transverse Arm Inner Cover

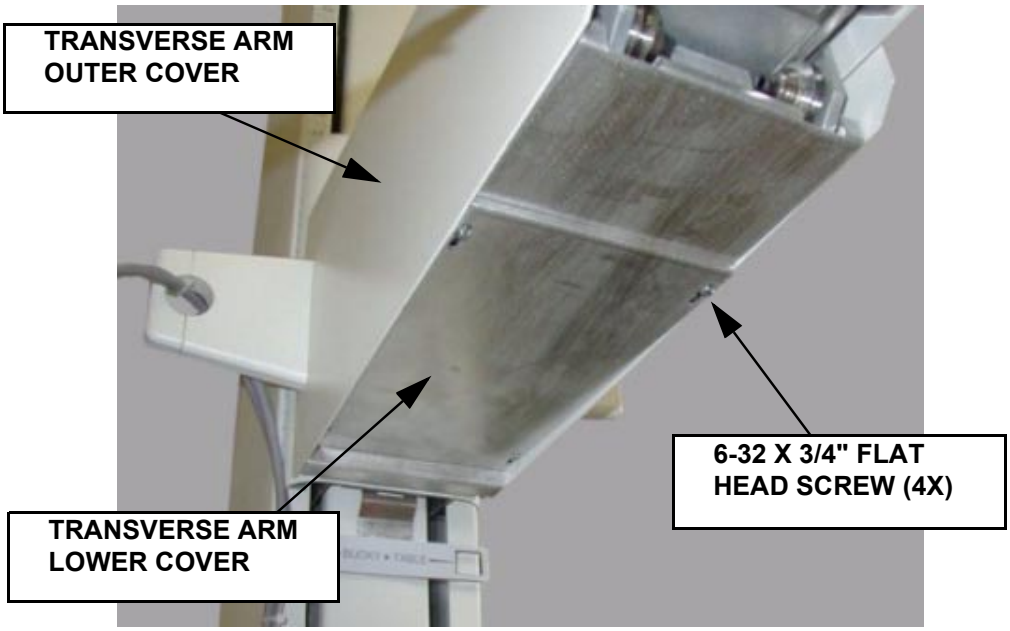


Figure 14. Installing the Lower Transverse Arm Cover

VERTICAL COUNTERWEIGHT BALANCING INSTRUCTIONS

1. Verify that the vertical counterweight is balanced properly, so that it provides a smooth up and down motion of the tube head.
2. If additional weights are necessary, remove access opening cover (at the rear side of the Vertical Column) and add trim weights as required (see Figure 15).

NOTE

Be careful not to drop trim weights when adding through opening in Vertical Column.

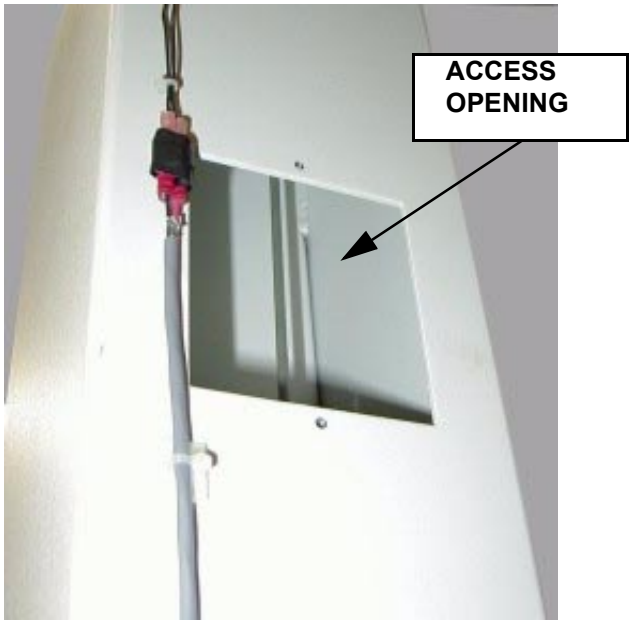


Figure 15. Trim Weight Access Opening (Rear Side of Vertical Column

VERTICAL COLUMN ROTATION ADJUSTMENT

Rotate the Vertical Column to feel the mechanical indexing. If too loose or too tight, the tension of indexing is adjusted by loosening or tightening two (2) 1/4-20 socket head screws, one on each side of the Vertical Column near the base (see Figure 16).

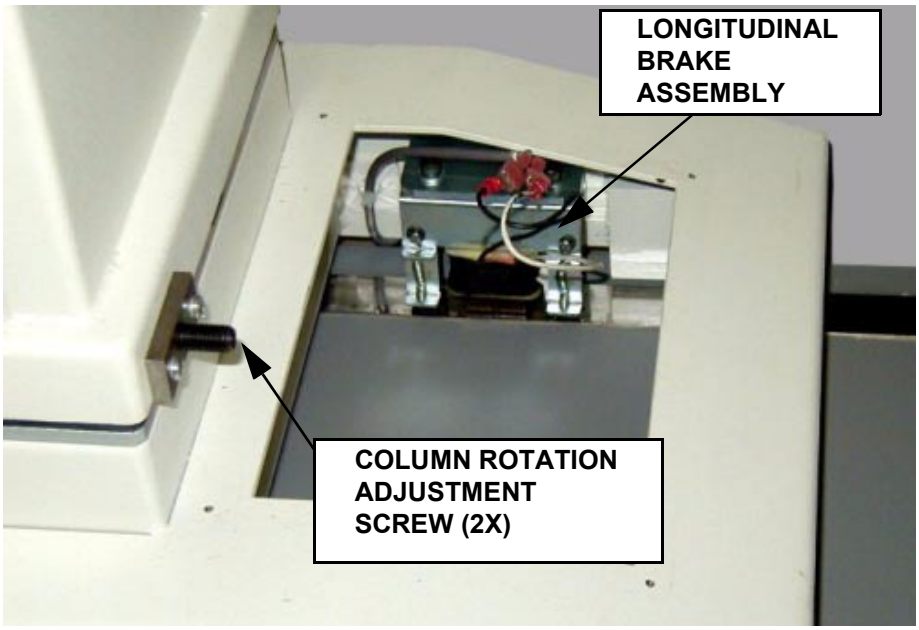


Figure 16. Vertical Column Rotation Adjustment Screws

ADJUSTING THE LONGITUDINAL BRAKE (ELECTROMAGNETIC LOCK)

The Longitudinal Brake Assembly is mounted inside the Base Assembly (on the anode side). To adjust height, proceed as follows:

1. Loosen two (2) 1/4-20 x 1" hex head bolts securing the Longitudinal Brake Assembly to the Base Assembly (see Figure 16).
2. The space between electromagnetic lock and contacting part of the Floor Track should not exceed 20/1000" (ideally between 10/1000" and 20/1000"). Adjust electromagnetic lock brake height as required.
3. When electromagnetic lock height is correct, re-tighten two (2) 1/4-20 x 1" hex head bolts.

HORIZONTAL SID SWITCH ASSEMBLY INSTALLATION

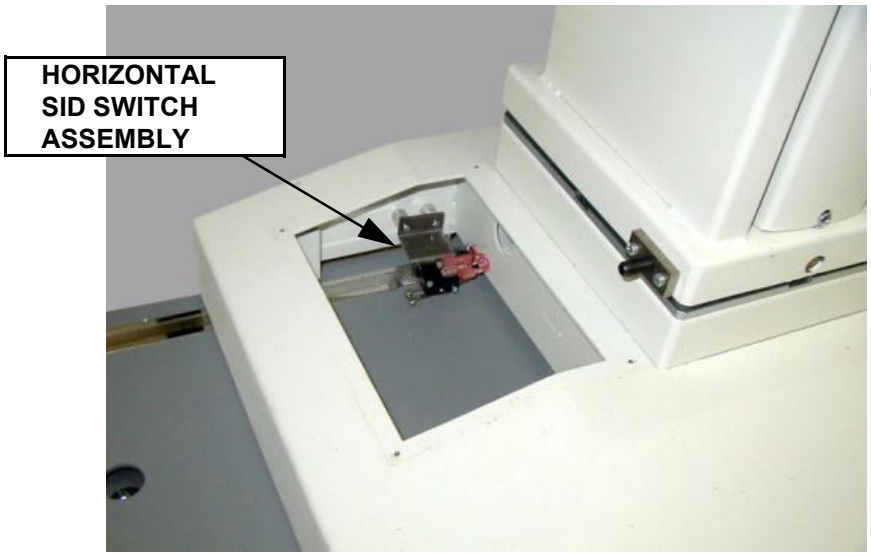


Figure 17. Horizontal SID Switch Installation

The Horizontal SID Switch Assembly mounts inside the Base Assembly (on the cathode side) as shown in Figure 17. Proceed as follows:

1. Remove four (4) screws securing left Base Access Panel to the Base Assembly and remove panel.
2. Loosely install Horizontal SID Switch Assembly on rear wall of Base Assembly using two (2) 10-32 x 1/2" phillips pan head screws, flat washers and kep nuts.
3. Using a Switch Actuator placed on the Floor Track as a reference (do not peel off adhesive backing at this time), adjust the height of the switch so that when it contacts the actuator, the switch activates (clicks).
4. When the switch height is correct, tighten the two (2) 10-32 x 1/2" phillips pan head screws.
5. Remove terminal strip cover from back of tube stand.
6. Connect six (6) wires from Horizontal SID Switch Assembly and Longitudinal Brake Assembly to terminal block TB1 as follows:
   - •RED TB1-6
   - •BLACK TB1-2
   - •YELLOW TB1-1
   - •GREEN TB1-1
   - •BROWN TB1-5
   - •ORANGE TB1-4
7. Re-install left Base Access Panel on the Base Assembly.
8. Re-install terminal strip cover on back of tube stand.

VERTICAL SID SWITCH ASSEMBLY INSTALLATION

The Vertical SID Switch Assembly mounts to the lower section of the Cable Clamp (on the anode side) as shown in Figure 18. Proceed as follows:

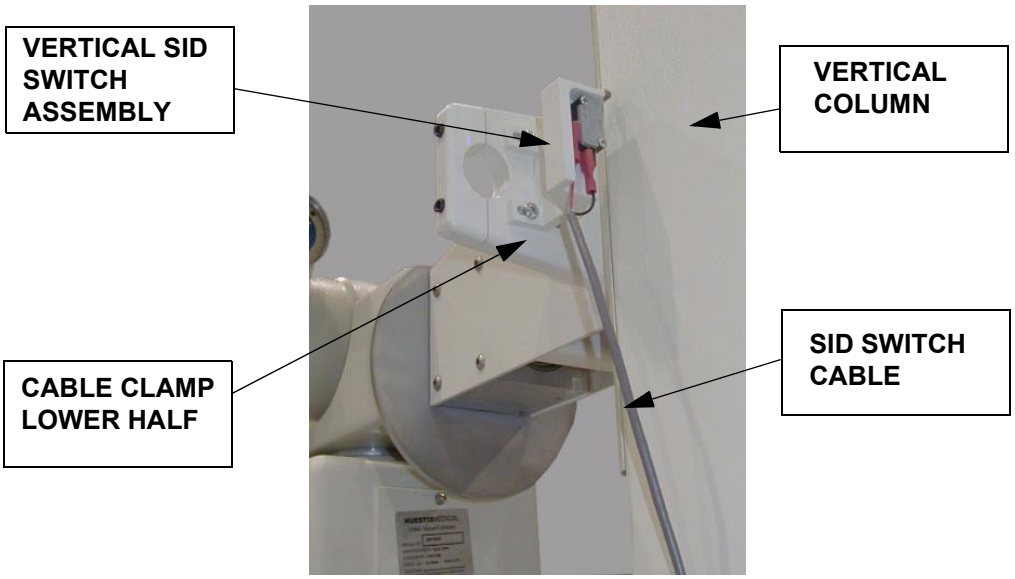


Figure 18. Vertical SID Switch Installation

1. Install two (2) Cable Clamp lower sections on each side of Tube Arm Extension using two (2) 1/4-20 x 2" socket head cap screws.
2. Loosely mount the Vertical SID Switch Assembly to the lower section of anode-side Cable Clamp using two (2) 10-32 x 1/4" socket head cap screws.
3. Using a switch actuator placed on the Vertical Column as a reference (do not peel off adhesive backing at this time), adjust the height of the switch so that when it contacts the actuator, the switch activates (clicks).
4. When switch height is correct, tighten the two (2) 10-32 x 1/4" socket head cap screws.
5. On SID switch cable (from terminal block TB1), connect red and black wires to NO and COM terminals, respectively, on Vertical SID Switch Assembly.

TUBESTAND INPUT POWER

The Tubestand requires a +24 VDC power input connection and, if equipped with digital type Handgrips, a +15 VDC power input. Proceed as follows:

1. Connect power input connector J2 to power source (e.g., x-ray generator). The input power source(s) must be double (or reinforced) insulated and meet construction/performance criteria per UL 2601-1.
2. Connect the +24 VDC and +24 VDC RTN wires on J2 to terminal board TB1-7 and TB1-8, respectively (see Figure 26 or 27 in Chapter 5, Diagrams). Terminal strip TB1 is located on the rear side of the Vertical Column. If using digital type Handgrips, connect the +15 VDC and +15 VDC RTN wires to terminal board TB1-9 and TB1-8, respectively.

CONNECTION OF THE HIGH-VOLTAGE CABLES/CABLE ROUTING

To make the required electrical connections, refer to the appropriate system interconnection diagram (see Figure 27 or 28 in Chapter 5, Diagrams) and proceed as follows:

1. Connect the Anode and Cathode high-voltage cables to the x-ray tube housing. Allow sufficient cable drape (see Figure 19) in order to angulate the x-ray tube 90 degrees clockwise or counterclockwise.
2. Insert the high-voltage cables along with the cables from the collimator, Handgrip Assembly, and Vertical SID Switch Assembly into corrugated (slit) tubing provided with system (the tubing will need to be cut to required lengths). Use tie-wraps to secure cable in slit tubing as required.
3. Fasten the corrugated tubing into the Cable Clamps (see Figure 19) on each side of the Vertical Trolley by installing upper halves of Cable Clamps to lower halves using two (2) 8-32 x 1" socket head cap screws.
4. From the Terminal Strip Assembly, route the tubestand cables along with the +24 VDC/+15 VDC power supply cable, to the x-ray generator.

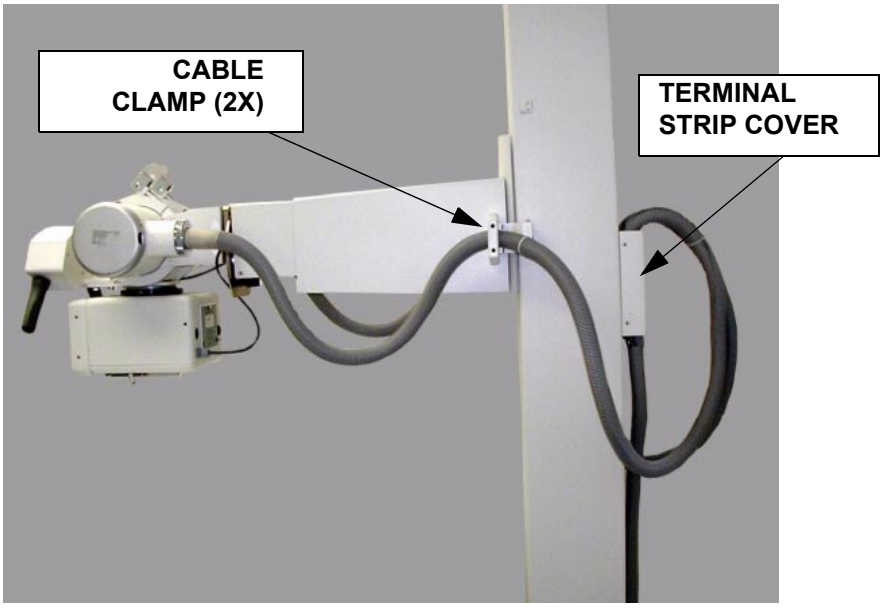


Figure 19. Cable Clamping and Management

HORIZONTAL SID SWITCH ACTUATOR/INDICATOR INSTALLATION

Install the Horizontal SID switches actuators and indicator decals as follows:

1. Position the Tubestand at 40" and 72" SID and mark each position on Floor Track.
2. Clean marked area with alcohol and secure actuator in marked location using double-sided tape. Check switch height to ensure activation at 40" and 72" SID.
3. Affix 40” and 72” (wall) SID indicators on Floor Track at each SID position.

VERTICAL SID SWITCH ACTUATOR INSTALLATION

The Vertical SID Switch actuating arm faces towards the Vertical Column.

1. Attach the Vertical SID Indicator Bracket to the Vertical Trolley. This is done by inserting the end of the bracket with the square cut-out and slot into the opening between the trolley and Vertical Column. The square opening in the bracket is then hung onto the inside of the trolley. Pull down on bracket to ensure it is fully seated in slot.
2. Bring the Vertical Trolley down to the desired 40" SID mark on the Vertical Column.
3. Mark the location for the Vertical SID Switch actuator.

NOTE

Bucky and table SID measurements and markings are made separately and independently of each other.

4. Clean marked area with alcohol and secure actuator in marked location using double-sided tape.
5. Check switch height to ensure activation at 40" SID.

VERTICAL DISTANCE SCALES

The Vertical Distance Scales mount on the front side of the Vertical Column (see Figure 20). The Vertical Distance Scales, calibrated in either centimeters (metric system) or inches (SAE system), indicate the focal spot-to-bucky and focal spot-to-tabletop distances.

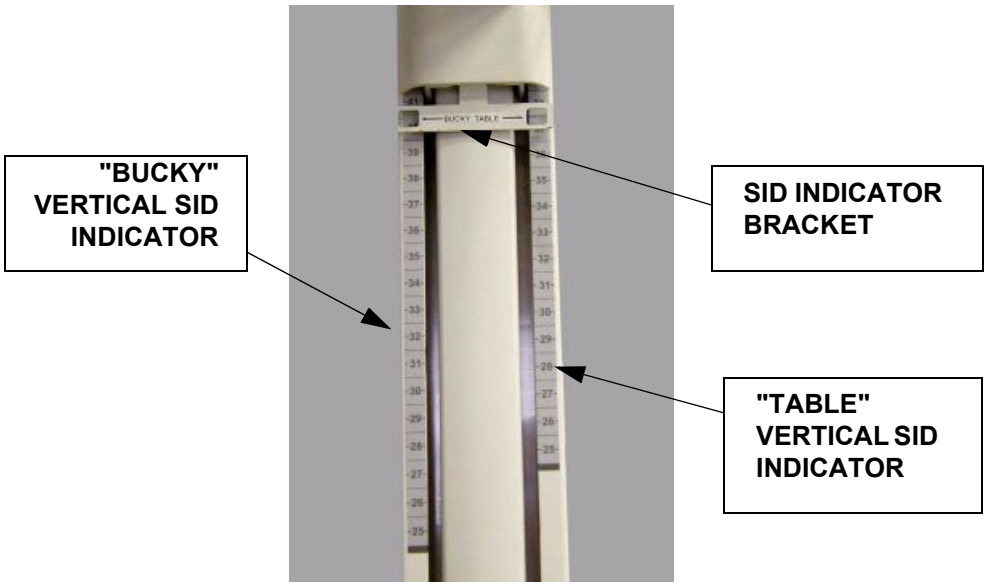


Figure 20. Vertical SID Scales Mounted on Vertical Column

Bucky SID

1. Set tube position for 40" (100 cm) bucky SID.
2. Affix label on Vertical Column so that the 40" (100 cm) mark lines up with the arrow in the bucky SID window of the SID Indicator Bracket.

Table SID

1. Set tube position for 40" (100 cm) tabletop SID.
2. Affix label on Vertical Column so that the 40" (100 cm) mark lines up with the arrow in the table SID window of the SID Indicator Bracket.

ANGLE CALIBRATION (DIGITAL HAND GRIPS ONLY)

The following procedure describes how to calibrate the tube angulation display for acccurate angulation measurements:

1. Simultaneously press ANGLE push button on the Handgrips and Calibration Mode pin switch (access hole is located on underside of handgrips). A screen prompt appears on the LCD requesting the tube be rotated to 0°.
2. Place a digital level on a flat surface either on top of the tube or collimator and rotate the tube/collimator to 0° position as indicated on the level.
3. Press the ANGLE push button on Handgrips to set position. A screen prompt appears on the LCD requesting the tube be rotated to +90°.
4. Rotate the tube/collimator counterclockwise to +90° position as indicated on the level.
5. Press the ANGLE push button on Handgrips to set position. A screen prompt appears on the LCD requesting the tube be rotated to -90°.
6. Rotate the tube/collimator clockwise to -90° position as indicated on the level.
7. Press the ANGLE push button on Handgrips to set position.
8. Simultaneously press ANGLE push button on the Handgrips and Calibration Mode pin switch to exit calibration mode.

ALIGNMENT OF THE SYSTEM

Once installed, the Tubestand must be aligned with other components of the x-ray system, such as a radiographic table and/or vertical wall stand. If both a radiographic table and vertical wall stand are used, align the table first, then the vertical wall stand. Alignment instructions are provided in the installation and operation manual provided with each component.

Refer to the collimator manual for additional alignments and performance verifications associated with beam limiting device.

NOTE

For this test, it is very important to use the collimator light for aligning the table and vertical bucky stand.

Collimator Light Field Versus Actual X-Ray Field

1. Using any size film with cassette, set the proper technique in the x-ray generator.
2. Make an exposure and develop the film to verify actual x-ray field versus collimator light field alignment is within required specifications.
3. Use collimator horizontal cross light to align the table. Rotate the x-ray tube to check the pitch adjustment as required.
4. Verify vertical movement and alignment with bucky stand or cassette holder using collimator light.

Chapter 3

THEORY OF OPERATION

Chapter 3 Theory of Operation

OVERVIEW

The Model QS-550 Tubestand is a free-standing x-ray tube support device (i.e., does not require wall and/or ceiling mounting) that provides a wide range of tube positions through longitudinal, vertical, rotational, and transverse tubestand motions. The Handgrip Assembly is designed for operator convenience with ergonomically positioned push button switches that enable tubestand movement when pressed. An LCD panel on the Handgrip Assembly displays essential tube location information, such as x-ray tube rotation angle, indication of 40" and 72" source-to-image distance (SID), and x-ray technique information (when the generator mode is set for APR).

The following paragraphs provide detailed theory of operation of the various tubestand functions. See Figure 27 or 28 in Chapter 5, Diagrams for system schematics.

THEORY OF OPERATION

VERTICAL MOTION OPERATION

The vertical motion of the x-ray tube is controlled by a fail-safe type "vertical brake"; when power is removed from the system, the brake remains mechanically locked. A +24 VDC input, typically provided from the radiographic system's x-ray generator, is applied through connector J2-2 and switch S5 to Vertical Lock Switch S1-1. When S1 is pressed, the +24 VDC is applied to electromagnetic Vertical Lock Coil L1, releasing the brake (i.e., magnetic lock) and enabling vertical positioning of the x-ray tube. When Vertical Lock Switch S1 is released, +24 VDC is immediately removed from L1 and the vertical brake (magnetic lock) is activated inhibiting x-ray tube vertical motion.

LONGITUDINAL MOTION OPERATION

The longitudinal motion of the x-ray tube (i.e., entire Vertical Column) is controlled by a "longitudinal brake" located in the tubestand's Base Assembly. The +24 VDC input is applied through connector J2-2 and switch S5 to Longitudinal Lock Switch S3-1. When S3 is pressed, the +24 VDC is removed from electromagnetic Longitudinal Lock Coil L1, releasing the brake (i.e., magnetic lock) and enabling longitudinal positioning of the x-ray tube. When push button S3 is released, +24 VDC is immediately applied to L3 and the longitudinal brake (magnetic lock) is activated inhibiting x-ray tube longitudinal motion.

ANGULATION MOTION OPERATION

The angulation motion of the x-ray tube (i.e., clockwise and counter-clockwise rotation of the x-ray tube) is controlled by an "angulation brake" located in the tubestand's Transverse Arm Assembly. The +24 VDC input is applied through connector J2-2 and switch S5 to Angulation Lock Switch S4-1. When S4 is pressed, the +24 VDC is removed from electromagnetic Angulation Lock Coil L4, releasing the brake (i.e., magnetic lock) and enabling rotation of the x-ray tube. When push button S4 is released, +24 VDC is immediately applied to L4 and the angulation brake (magnetic lock) is activated inhibiting x-ray tube angulation motion.

TRANSVERSE MOTION TRAVEL

The transverse motion of the x-ray tube (i.e., cross-table movement of the x-ray tube) is controlled by a "transverse brake" located in the tubestand's Transverse Arm Assembly. The +24 VDC input is applied through connector J2-2 and switch S5 to Transverse Lock Switch S2-1. When S2 is pressed, the +24 VDC is removed from electromagnetic Transverse Lock Coil L2, releasing the brake (i.e., magnetic lock) and enabling transverse motion of the x-ray tube. When push button S2 is released, +24 VDC is immediately applied to L2 and the transverse brake (magnetic lock) is activated inhibiting x-ray tube transverse motion.

ALL LOCKS RELEASE OPERATION

The All Locks Release button provides the operator with a single button that, when pressed, enables x-ray tube positioning in the vertical, longitudinal, rotational, and transverse directions simultaneously. The +24 VDC input is applied through connector J2-2 to normally-closed switch S5-2 and S5-5. With the switch closed, the +24 VDC power input is routed through contact S1-1 to the Transverse Lock Switch S2-1, Longitudinal Lock Switch S3-1, and Angulation Lock Switch S4-1 and to contact S5-4, which is not connected. The +24 VDC is then routed through switches S2, S3 and S4 to the Transverse, Longitudinal, and Angulation Lock Coils L2, L3, and L4, respectively, which activate the locks for each of these motions. The fail-safe Vertical lock remains locked since the +24 VDC is not connected in this switch state.

When switch S5 is pressed, the +24 VDC power input is routed to switch contacts S5-3 and S5-4. In this state, +24 VDC input power is removed from the Transverse Lock Switch S2-1, Longitudinal Lock Switch S3-1, and Angulation Lock Switch S4-1 disabling the locks (thus enabling transverse, longitudinal, and angulation x-ray tube motions). The +24 VDC power input is routed through switch contact S5-6 to the fail-safe Vertical Lock, releasing the brake, thereby enabling vertical motion of the x-ray tube.

AUTO-STOP OPERATION

The Auto-Stop function is provided to enable quick longitudinal positioning of the x-ray tube at the 40" (or 100 cm) and 72 "(or 180 cm) SID positions. This function requires that the operator simultaneously press the Longitudinal Lock Release button (switch S3) and the Auto-Stop button (switch S6). The circuit operation is as follows:

The +24 VDC input is applied through connector J2-2 to 40" Table SID switch S1, 40" Wall SID switch S2, and 72" Wall SID switch S3. If the tubestand's Vertical Column is moved over a 40" or 72" SID actuator on the floor track, it closes the corresponding SID switch, which routes the +24 VDC to the Longitudinal Lock Coil L3. The longitudinal brake (magnetic lock) is activated, locking the x-ray tube in the current SID position. To re-activate the Auto-Stop function, both the Longitudinal Lock Release and Auto-Stop buttons must be pressed.

HANDGRIP DISPLAYS (ANALOG-TYPE)

The analog type Handgrip displays include a bubble level, which is used for reading the rotation angle (i.e., "angulation") of the x-ray tube, and two SID light-emitting diodes (LEDs). When the Vertical Column is positioned over the 72" SID actuator, located on the floor track, +24 VDC is applied from connector J2-1 through 72" Wall SID switch S3, to the 72 Inch LED, lighting the LED. Similarly, when the Vertical Column or the Vertical Trolley is positioned over the 40" SID actuator, +24 VDC is applied from connector J2-1 through 40" Wall SID switch S2 or 40" Table SID switch S1, respectively, to the 40 Inch LED, lighting the LED.

HANDGRIP DISPLAYS (DIGITAL-TYPE)

The digital type Handgrip contains a liquid crystal display (LCD) that provides the user with digital display of the following information:

- Indicates the source-to-image distance (SID) - 40" (100 cm) or 72" (180 cm), with "T" for table receptor or "W" for wall receptor.
- When Quantum Medical Imaging, LLC. x-ray generator is in APR mode, it displays the current exposure selections (e.g., kVp, mA, time, etc.). When not in APR, displays either "MANUAL" or "AEC", depending on the mode selected. Also displays the current time and date.
- Indicates x-ray tube rotation angle.

In addition, handgrip switch status and built-in test data is serially transferred from the Handgrips to the x-ray generator microprocessor for processing.

The following paragraphs provide theory of operation for each display function. Refer to functional block diagram of LCD Display Control Board A1 (AY40-001T) in Chapter 5, Diagrams.

SID Display

Because the display of the 40" table, 40" wall, and 72" wall SID positions on the LCD are similar, only the display of the 40" table SID position will be described in detail.

When the 40" table SID switch S1 is activated (by contact with an actuator mounted on the Vertical Column), +24 VDC is connected from J2-1 through connectors J2 and P2 to LCD Display Control Board A1. The signal is buffered by A1U1 and applied to Microcontroller A1U8, where the signal is processed into SID readout data for output LCD Display EL31-005.

Exposure Selection Display

Serial data, containing information about current exposure selections, current time, and current date is transmitted via an RS-485 serial cable to the LCD Display Control Board A1. The data is applied through RS-485 transceiver A1U10 to Microcontroller A1U8 and to RS-232 transceiver A1U14. Transceiver A1U14 converts the data to RS-232 serial data for output to a computer (not provided with system) for PC diagnostics.

Microcontroller A1U8 is programmed to process the exposure selection data to produce the required data output necessary for digital display of the technique selections on the Handgrip front panel LCD. EPROM A1U9 contains 64k x 16 of external memory for Microcontroller A1U8. Registers A1U11 and A1U12 provide storage for input and output data to/from EPROM A1U9.

Rotation Angle Display

The x-ray tube rotation angle is sensed by ANGLE potentiometer R1, which is located in the tubestand handgrips. As the tube is rotated from +90 degrees (CCW) to -90 degrees (CW), the resistance across R1 decreases, causing the voltage level of the ANGLE signal to decrease proportionally. (At 0 degrees, the voltage equals 2.05 VDC.) The ANGLE signal is applied to Microcontroller A1U8, where the signal is processed into Rotation Angle readout data for output to LCD Display EL31-005. Regulator A1U13 regulates the +5 VDC on board voltage to +4.1 VDC reference level for ANGLE potentiometer R1.

For accurate voltage scaling, ANGLE potentiometer R1 requires calibration when it is replaced, or when LCD Display Control Board A1 (AY40-001T) is replaced. Also, following installation, the ANGLE potentiometer must be calibrated (refer to Chapter 2, Assembly & Installation for angle calibration instructions.)

LCD Display Control Board A1 (AY40-001T) Circuits

Other circuitry present on the LCD Display Control Board A1 (AY40-001T) are as follows:

- A reset pulse (RESET) is generated either automatically by A1U7 following power-on, or manually by pressing RESET switch A1SW1. This signal resets Microcontroller A1U8 and LCD Display EL31-005 to reset state.
- The +15 VDC power input from the x-ray generator and is applied to regulators A1U3 and A1U4. Regulator A1U3 generates regulated +12 VDC for DC-AC inverter A1U2. Regulator A1U4 generates regulated +5 VDC supply voltage for powering logic microcircuits on LCD Display Control Board A1.
- DC-AC inverter A1U2 generates 400 VAC output (from +12 VDC), which is applied to LCD Display EL31-005. The 400 VAC is required supply voltage to power fluorescent backlighting of the LCD display window.
- A1U5, A1U6 and potentiometer A1R5 control the contrast voltage output to LCD Display EL31-005. Adjusting A1R5 changes the voltage level to the LCD Display. Varying this voltage level increase/decreases the contrast setting of the LCD display.

Chapter 4

SERVICE INSTRUCTIONS

Chapter 4 Service Instructions

OVERVIEW

This chapter is designed to assist the service technician in maintaining the smooth operation of the tubestand. The tubestand will function reliably when maintained according to the instructions provided in this chapter. Safe equipment performance requires the attention of service personnel who are specifically trained and experienced with medical x-ray apparatus. Applicable preventive maintenance or any repair service should be performed by these skilled individuals. Failure to follow manufacturer's or service personnel's recommendations may result in serious injury.

WARNING! Personnel engaged in maintenance activities should exercise normal caution and care while working with electro-mechanical equipment. Before removing or opening any electrical power panels or covers, verify that the incoming power supply is turned OFF. In the event maintenance procedures require power to be supplied to the unit, extreme care MUST be exercised to insure the safety of service or other personnel in the area. Verify equipment is properly grounded before attempting any electrical operation.

SERVICE MAINTENANCE

WARNING! Always disconnect the equipment from the main power supply prior to any cleaning.

Visual Inspection

The following inspection and adjustment procedures are recommended to maintain the system in its original operating condition.

Perform Every Six Months:

- Check for evidence of loose hardware or loose wires
- Check all bearings and bearing surfaces for cleanliness and corrosion
- Clean Bearing Tracks, Floor Track
- Conduct a general inspection for worn or damaged parts
- Check for proper counterbalancing and smoothness of vertical (up/down) tubestand motion
- Verify that all ground conductors are properly and securely installed and free of corrosion or damage
- Check all electrical cabling and wiring for wear and fraying

REPLACEMENT PARTS AND ORDERING INFORMATION

Table 2 provides a list of replaceable parts for the tubestand. Figures 21 through 26 show the locations of the replaceable parts in the system.

Table 2. Replaceable Parts

Item	Description	Part Number	Qty Used on System
1	Magnet, Small (Transverse)	EL58-002	1
2	Magnet, Large (Longitudinal, Angulation)	EL58-001	2
3	Fail-safe Brake	EL80-002	1
4	SID Switch Actuator	ME10-218	3
5	SID Switch	EL50-006	2
6	SID Indicator Light, Blue	EL31-003	2
7	Push-button Switch, Transverse	EL50-002-1	1
8	Push-button Switch, Longitudinal	EL50-002-2	1
9	Push-button Switch, All Locks Release	EL50-002-3	1
10	Push-button Switch, Auto-Stop	EL50-002-4	1
11	Push-button Switch, Angulation	EL50-002-5	1
12	Push-button Switch, Vertical	EL50-002-6	1
13	LCD Display	EL31-005	1

ORDERING INFORMATION

To order replacement parts for the tubestand, contact the Service Department at;

Quantum Medical Imaging, LLC.
2905 Veterans Memorial Highway
Ronkonkoma, New York 11779 USA
Phone: (631) 587-5800

When ordering replacement parts, supply the following information:

- Model and serial number of equipment
- Part number
- Part description
- Quantity required

When ordering components or parts not listed in Table 2, a complete description of the part, including its function and location should be provided with the model number and serial number of the unit.

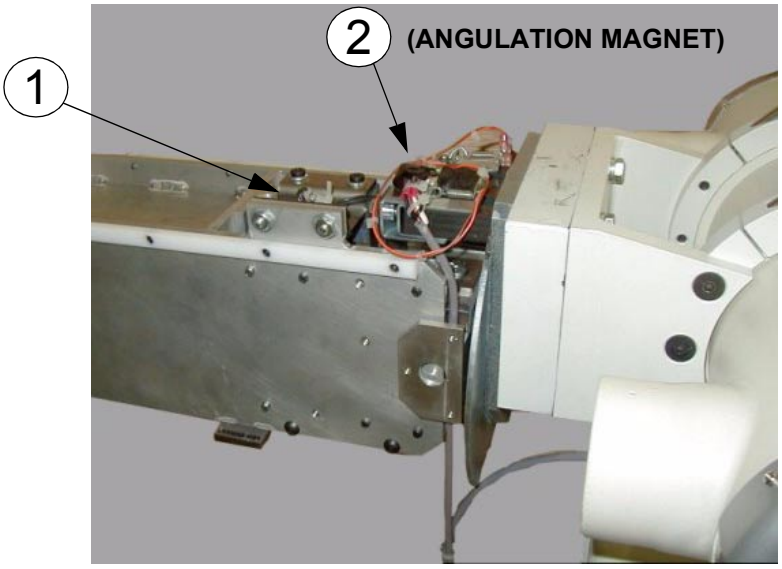


Figure 21. Model QS-550 Tubestand Parts Location Diagram

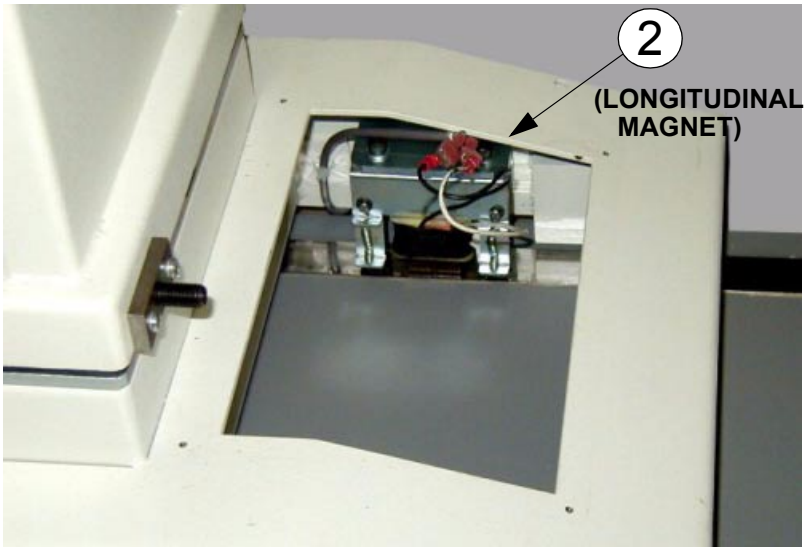


Figure 22. Model QS-550 Tubestand Parts Location Diagram

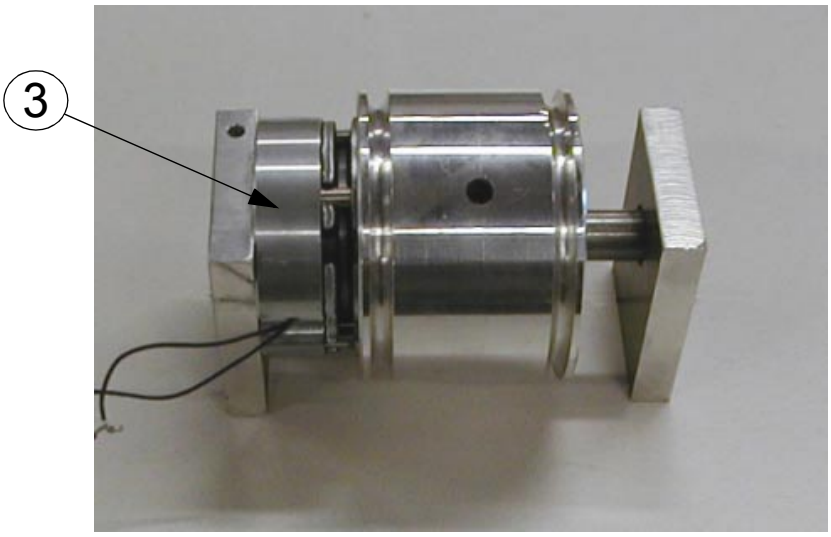
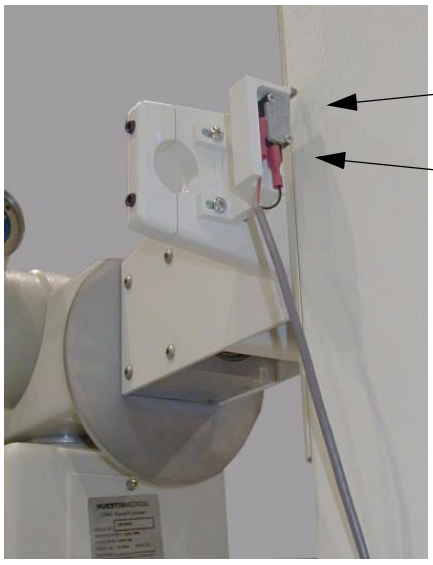


Figure 23. Model QS-550 Tubestand Parts Location Diagram



NOTE: Vertical SID switch and actuator are shown in Figure 23; the Horizontal SID switch, located in the Base Assembly, and longitudinal actuators have the same respective part numbers.

Figure 24. Model QS-550 Tubestand Parts Location Diagram

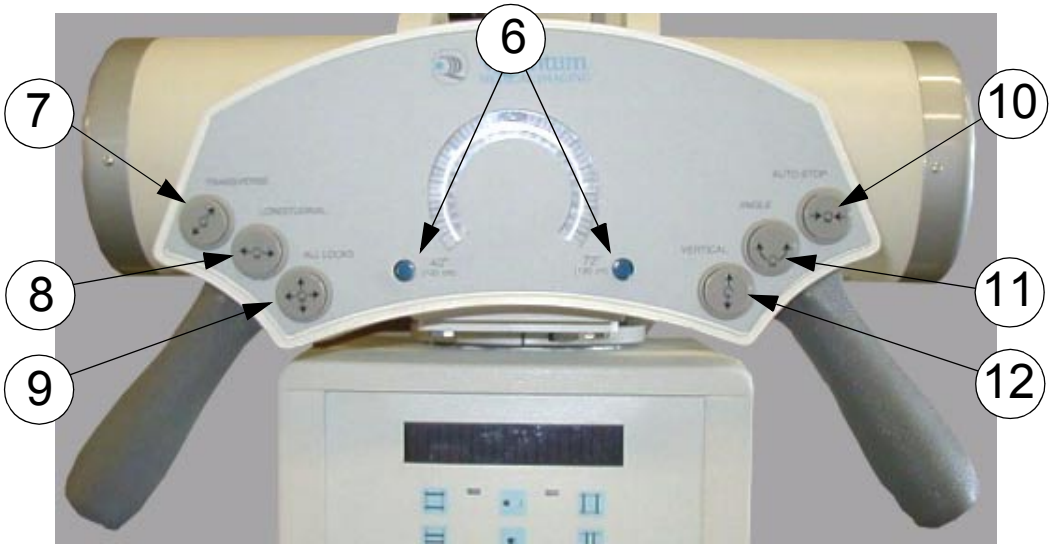


Figure 25. Model QS-550 Tubestand Parts Location Diagram

Figure 26. Model QS-550 Tubestand Parts Location Diagram

Chapter 4 Service Instructions

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Chapter 5

DIAGRAMS

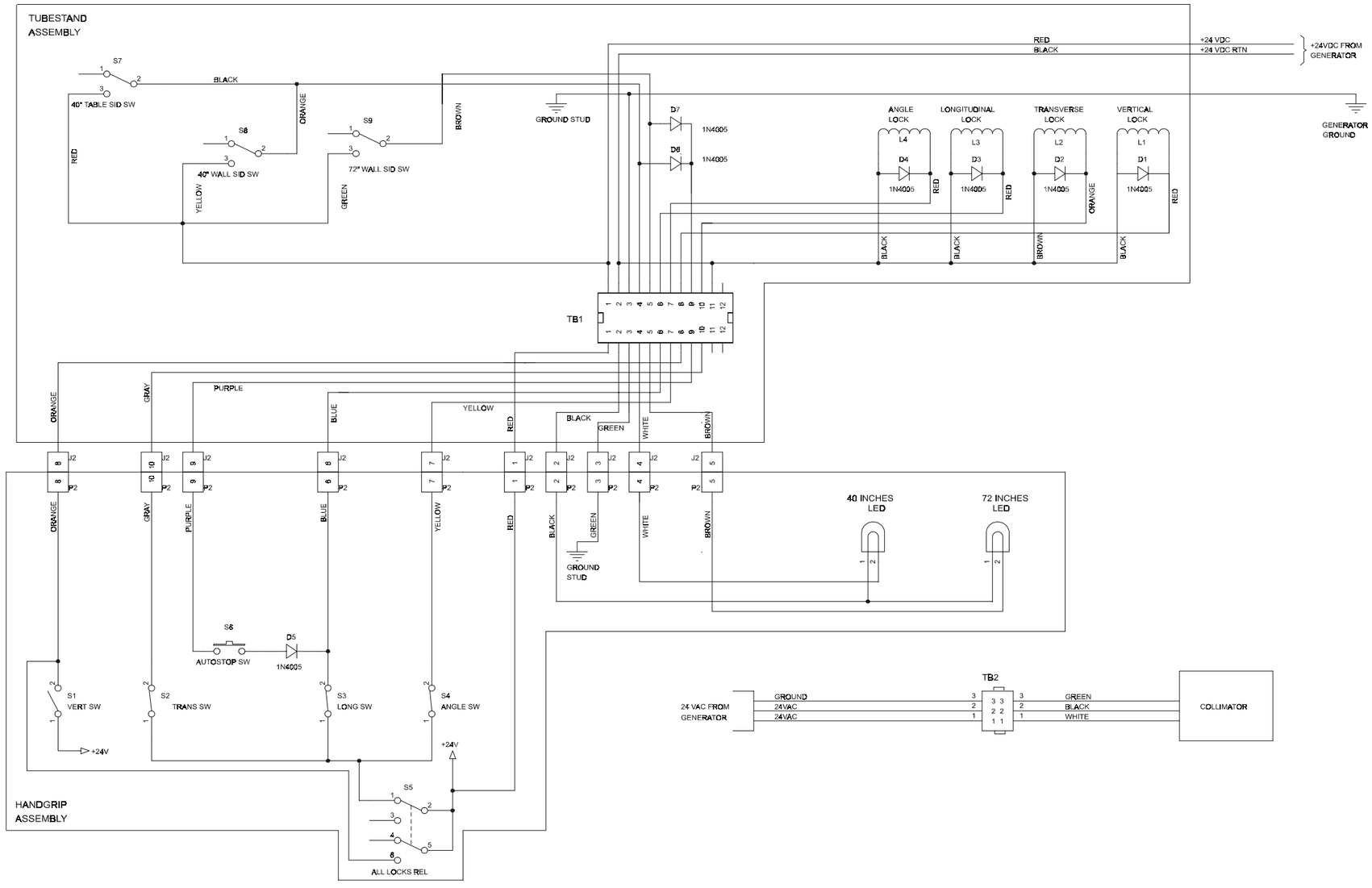

Figure 27. Model QS-550 Tubestand Wiring Diagram (Analog Handgrips)

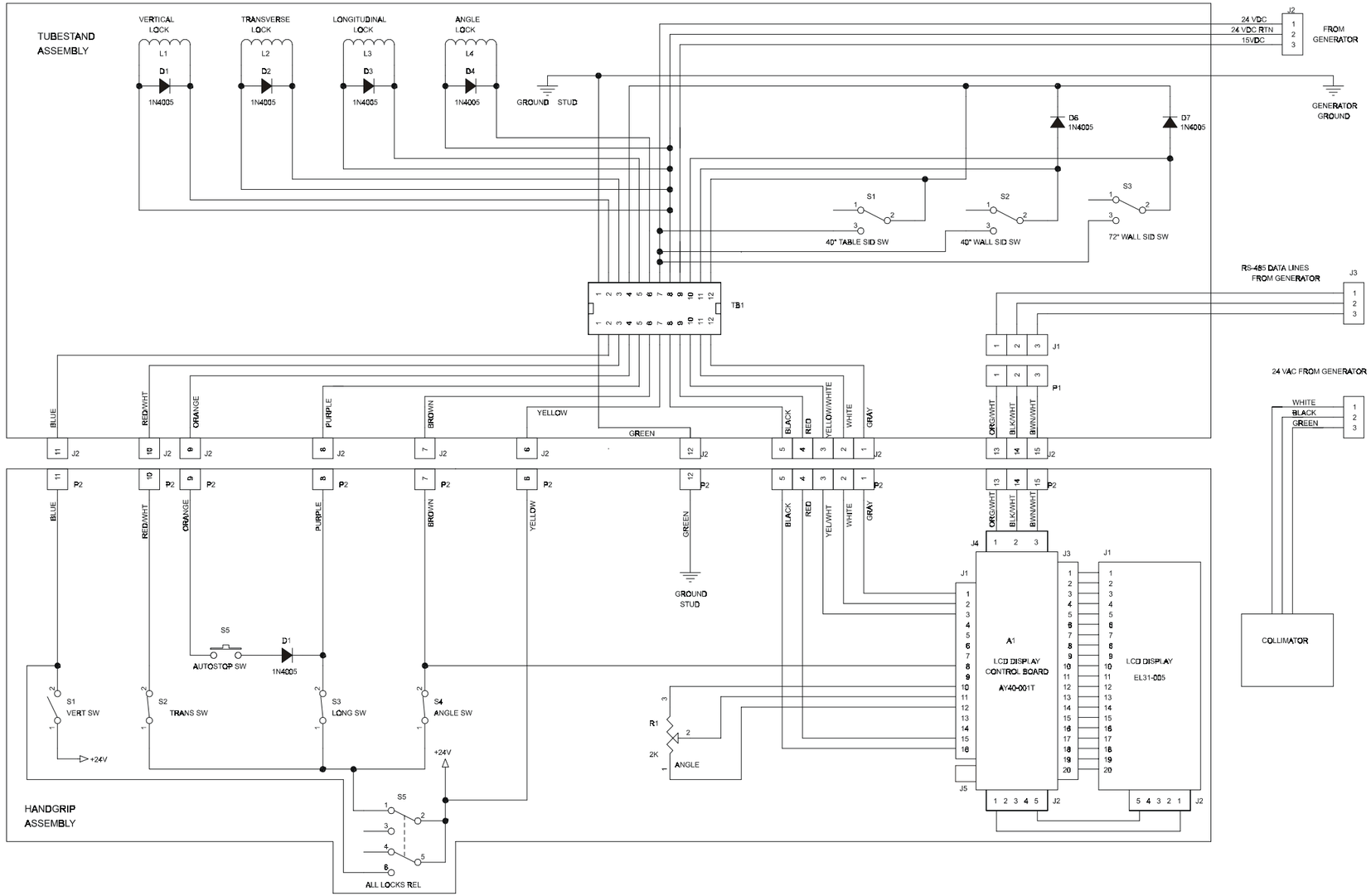

Figure 28. Model QS-550 Tubestand Wiring Diagram (Digital Handgrips)

LCD DISPLAY CONTROL BOARD A1 (AY40-001T)

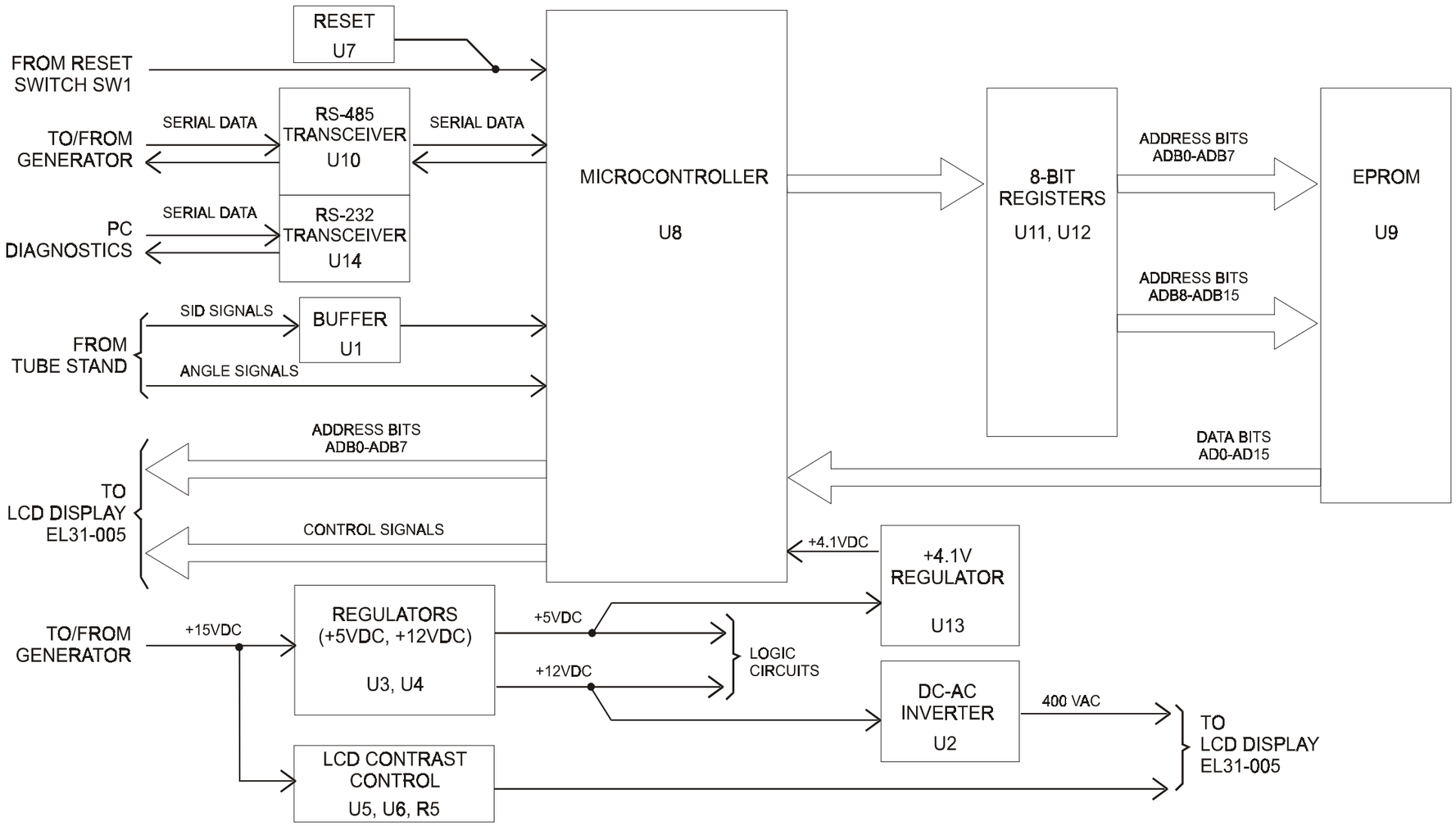

Figure 29. LCD Display Control Board A1 (AY40-001T) Functional Block Diagram